Large Timber Structures in Western Australia *

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SUMMARY: *As the result of a AU$11,000 Grant through the 1993/94 Australian National Estates Grant Programme, the members of the Engineering Heritage Panel of the Western Australia Division of the Institution of Engineers, Australia, have completed a five volume survey and recording of a number of Large Timber Structures in Western Australia[1] which was initially started by the late Mr Denis Cumming in 1993.*

The survey covered Road Bridges, Railway Bridges, Footbridges, Timber Company Bridges, Forestry Department Bridges, Jetties, Air Transport Structures, Maritime Structures, Military Structures, Mining Structures, Railway Water Tanks, Forestry and Timber Milling Structures, Water Supply Tanks and Major Timber Power Lines.

Some 850 structures were listed of which 139 have been selected as having a high degree of engineering heritage which should be considered for State Listing.

The Paper covers the process by which this project was undertaken, the documentation and final presentation of the survey.

1 STUDY OBJECTIVES

The aim of the study was to make a survey of the whole range of Large Timber Structures in Western Australia, which represented the output of an industry which was of great importance to the development of the State of Western Australia.

These structures also represented the result of the design and construction skills of a range of government instrumentalities, including the Public Works Department, the Main Roads Department, the Western Australian Government Railways, the Forests Department(latterly the Department of Conservation and Land Management), as well as those of timber milling companies, building and civil engineering contractors and the Australian Army.

Such large timber structures are under-represented in the registers of the National Estate and the Heritage Council of Western Australia and often differ considerably in design and construction from those of similar types in the eastern states. A further aim was to prepare an initial list of large timber structures that are considered to have outstanding heritage value.

2 TYPE OF STRUCTURE

The most significant type of large timber structures considered in the study was the bridge, which was dealt with under five categories; Road Bridges, Railway Bridges, former Timber Company Tramway Bridges, Forestry Bridges currently in use, and Footbridges.

The Jetty was another type of large timber structure which has been of great importance to the State in the past and which was included in this report in a supplementary manner to a report prepared by Mr Denis Cumming in 1994/95 entitled “Port-related Structures in Western Australia”.[2]

Other types of large timber structures considered were associated with transportation; namely Airport Hangars, Railway Goods Sheds, Tank Stands, Signal Boxes and Port Storage Sheds,

Industrial use structures include Mining Headframes, Ore Bins, Timber Mill Sheds and Forestry Fire Observation Towers, with other forms of infrastructure, such as Power Transmission Towers, Water Supply and Flood Control structures, and former Military Wartime Storage Sheds were also surveyed.

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Other types of buildings, built largely of timber, such as Agricultural and Pastoral Sheds, Factories and Warehouses, were not included as a survey in each of these areas would be a major undertaking in itself.

3 JUSTIFICATION

Many of the structures considered in the study were nearing the end of their useful lives. Some were being considered for replacement and were to be demolished, abandoned or put to other uses. Others, such as timber company tramway bridges and the older jetties have already been abandoned.

The remains of these vary in condition, from structures that have only recently become unserviceable, to impressive ruins with the skeletons of their main structural members still intact, and to other remains, the evidence of which is barely discernible to the general public.

The operating and owning authorities and those with control of land containing redundant structures, need some guidance as to the importance of such structures, and also in the procedures for selecting those which can be retained and conserved, and in managing ruins in such a way that their rate of deterioration is slowed, and so that they do not become unreasonable dangers to the public.

4 PROCEDURE

In 1994-95 Denis Cumming made inspections of jetties and maritime structures throughout the State in conjunction with work on other studies, and also inspected a number of important road and railway bridges, and other railway and water supply structures for his study. His findings have been incorporated in the report.

The Working Party was fortunate enough to be able to call upon the services of three experts in particular fields covered by the study; Mr Bill Larke, former Westrail Chief Engineer Civil, Mr Lloyd Margetts, Main Roads Western Australia Bridge Engineer with particular expertise in the interpretation and maintenance of timber road bridges, and Mr Max Anderson, former Chief Engineer of the Harbour and Rivers Branch of the Public Works Department. These gentlemen have been able to supplement Denis' work with their extensive professional knowledge of the structures covered by the study.

As far as timber company tramways are concerned, we have been fortunate in receiving the assistance of Mr Jeff Austin, who in 1994 prepared a report, "Sawmilling, Firewood and Other Tramways" for the National Trust of Australia (Western Australia),[3] and who made supplementary notes for this report in 1995. No further inspections of tramway bridges have been possible and much remains to be done in this important field of industrial heritage.

For information on the Department of Conservation and Land Management's forestry bridges, we have relied upon a 1994 Bridge Inspection Report which the Department kindly made available.[4] The larger bridges in that report have been included as a tentative, preliminary, measure. Their inclusion will highlight the fact that some of them may, at some future date, be classified as items of industrial heritage as a means of interpreting how forestry workers of the day went about their business. Without them, no report on large timber structures in this State would be complete.

5 LARGE TIMBER BRIDGES

5.1 Definition

A judgement was made to define a large timber railway bridge as a structure with 7 or more openings or 30 or more metres in overall length or having a height greater than 3.5 metres, provided the bridge has 3 or more openings.

All bridges meeting this criteria have been recommended for either further assessment or listing. Lesser bridges have been recommended on criteria such as age, engineering uniqueness or rarity associated with historic events, persons, precinct etc. In general, only current existing bridges have been recommended but some important sites of ruins have also been recommended for attention.

The span of a timber railway bridge normally means the clear span between half cap edges. Height is measured between the stream bed and soffit of beams (water level for permanent water). Overall length is usually taken as over the extent of decking.

5.2 Large Timber Bridge Inventory

In 1996, the Working Party decided that if the maximum benefit was to be gained from this exercise, the study report should contain as full an inventory as possible of all the major bridges in the State. The detailed criteria for inclusion in each bridge category are discussed in the introduction to each section on bridges. Several factors contributed to this decision.

Firstly, the large number of timber bridges in the State, and their dispersal over such a large area, made the identification of those with heritage value very difficult without having the benefit of a systematic revue of all bridges, even for those with a lifetime's experience in the field.

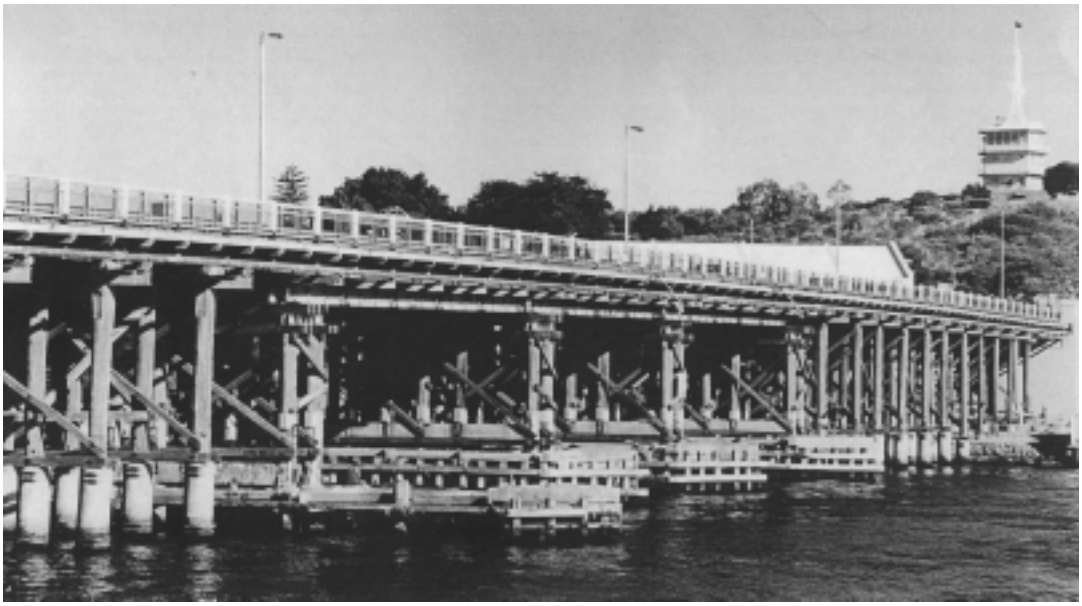

Figure 1: Fremantle Road Traffic Bridge, over Swan River at Fremantle Harbour. Built 1936, 26 spans totalling 205.49 m.

One of the aims of the study was to prepare an initial list of large timber structures which were considered to have a high heritage status. In future it was hoped that, when this first cohort has been fully documented and registered, there will be a demand for the registering of further examples. To provide as full an inventory of bridges at this stage will make future registrations a far easier task and will negate the need for another broad review.

Another factor of importance was the closure of Westrail's civil engineering design section, and the reorganization of its archives and divisional inspection services. It seemed prudent to access all the relevant information required on the Westrail bridges using familiar sources, as this would undoubtedly prove more difficult in the future when much of the material may be of no further value to Westrail.

At the same time, Main Roads Western Australia had increased the coverage of its inventory of timber bridges so as to make an inventory of all major bridges a possibility.

The production of an inventory of major timber bridges throughout the State has been no small task. However, with the exception of a handful of railway bridges on several poorly documented closed lines and bridges on the Trans-Australain Railway, the task has been completed despite funding limitations.

It should be remembered, however, that some aspects of the study had, of necessity, been limited to a desk exercise. In the future, when nomination forms are being completed for the heritage registration of those structures that are to be recommended by the report, it may well be necessary to make a thorough site inspection of each of the recommended structures.

6 HERITAGE ASSESSMENT

All items in this report were assessed for their heritage value as structures in terms of the recognised criteria of importance; namely, aesthetic, historic, technological, and social together with the degrees of significance being rarity, representativeness, condition, integrity and authenticity.

Most of the structures listed in Volume I of the total five-volume report, are of importance from at least two or three of these aspects. Where the technological and historical importance of a structure has been emphasized, it has been considered from the viewpoint of how best it interprets the work of those who built and used it in their work. If less emphasis has been given to the aesthetic consideration of a structure, it was because it was assumed that the beauty and integrity of a bridge or jetty or the timber frame of a large building needs no advocate.

7 HERITAGE VALUES OF ASSETS STILL IN USE

During the working life of different classes of government-owned assets, such as bridges or dams, it was considered that managers should be encouraged to identify specific examples which are outstanding, or typical examples of particular types, and which, in the future, could be retained as heritage items.

This would enable future generations to better interpret how instrumentalities carried out their important statutory functions on behalf of the State, and would also help them to appreciate skills and crafts possibly no longer in use, together with the beauty and functional aesthetics of their products. When

Figure 2: Lower Kalgan Bridge over Kalgan River, Albany. Only surviving WA road bridge with timber trusses.

such assets are in the latter parts of their working lives, maintenance on them should be continued so that, when no longer in use, they do not deteriorate so rapidly that authorities feel obliged to "make them safe" by demolition. Assets which were identified in this way should be eligible for special maintenance grants to owners from heritage authorities. Where such assets are sold to private companies, or reserves containing them are leased to other authorities or companies, the State Government should be encouraged to include in the sale or lease agreement caveats requiring retention of these structures and controlled public access to them.

8 RANKING SYSTEM

A numbered ranking system has been devised to indicate the industrial heritage status of timber railway bridges and sites. The system also indicates a recommended course of action and indicates priority and importance by ascending number order. The categories used are described hereunder:

1. Where no industrial heritage value exists or where it does not fit into the defined category of a large timber structure. Also, those sites already destroyed beyond interpretation.

2. Where there is a bridge of limited industrial heritage significance but should not be replaced or altered or the remains of ruins should not be destroyed without further assessment or recording.

or

   Where the bridge does not fit the defined category of a large timber structure but should be recorded and maintained as being most significant to industrial heritage.

3. The bridge ruin is beyond useful repair or site of significance to industrial heritage with a location or circumstances such as the heritage value can be usefully displayed.
4. Register and maintain as an important industrial heritage structure. For abandoned bridges, seek alternative uses or means of preservation; for bridges in service, seek the owner's cooperation to retain and maintain it.

5. As for 4 but urgent assessment is required as the bridge is subject to alteration, demolition or various types of damage or destruction.

Eighty-one bridges have been given Rankings 4 or 5 and were considered to be of major heritage importance. Of these bridges, 50 have been classified as being of very high heritage value. Twenty-five of these 50 have been given "very urgent" priority status. Data sheets and photographs of the 50 very high value bridges are included in this volume of the report and the 25 recommended for urgent attention were also identified and marked with a double asterisk on the data sheets.

9 ROAD BRIDGES

The first substantial road bridge in Western Australia, at Drummond's Crossing at Guildford, was built in 1835. Only a handful of other road bridges were completed in the period up to 1850, when the first shipload of convicts arrived.

The arrival of the first contingent of Royal Engineers, in December 1851, meant that the convict labour could be adequately supervised, and that the construction of public works (including roads and bridges) was greatly accelerated. The effect of using

this small group of engineers, combined with the ready availability of good bridge timber, was that simple standardized structures were usually built.

The evolution of the Public Works Department saw the reinforcement of the trend towards simple, easy-to-build-and-maintain bridges. The main differences between the timber bridges were either evolutionary improvements or were aspects of standard solutions related to parameters, such as height and foundation conditions.

Significant detail changes over time have included the general change from round timber fullcaps over the piles at each pier, to the more-easily maintained sawn timber halfcap system. Early bridges rarely used corbels, but the use of these to support stringers over piers was almost universal by the 1890s. Sawn jarrah stringers were normal between the 1890s and the late 1920s - when round stringers were adapted for their greater strength. A different superstructure system - that of supporting longitudinal decking over transverse bearers, on wider-spaced round stringers - was adopted for a period during and immediately following World War Two. Many other minor details are characteristic of particular time periods.

The years have seen major changes in the approach of durability requirements to timber bridges. Initially, the bridges were built as “craft” items - with natural drainage optimized and surfaces sloped to shed moisture. Ironwork fastenings were usually pickled in tar before use in timber. In time, bridges were built faster and more cheaply - but with less durability. The economic imperative of recent years has seen a return to the concept of structural timber durability - this time, achieved by the synthetic means of applied waterproofing materials, diffusible chemical fungicides, and reinforced concrete deck overlays.

The development of new preventative maintenance techniques to extend the service life of road bridges in use in Western Australia has automatically increased the options available for conservation of heritage-related structures. It is expected that appropriate application of preservation technology will allow many structures to survive safely with minimum expenditure, while decisions are made and funds are found for the full-scale conservation of those items identified to be of special importance.

There are approximately 1,500 bridges in service on public roads in Western Australia plus approximately another 150 on roads reserved for the use of the Water Corporation and the Department of Conservation and Land Management. In addition, there are over 20 closed road bridges and ruins of bridges which are of heritage importance. This section of the report surveys 282 of these bridges (but excludes CALM bridges in the south western forests which were dealt with in another section). It was intended that all significant timber road bridges in the following categories be included:

1. Historic bridges including those no longer in service,

2. Major bridges of more than 4 spans,

3. Bridges with significant heritage features,

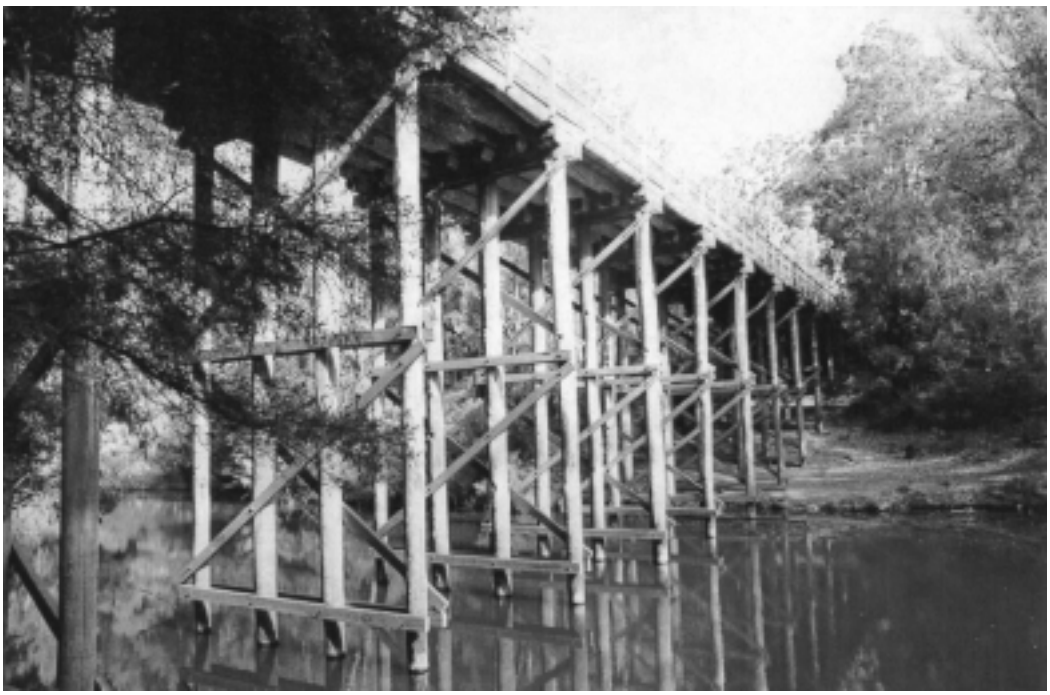

Figure 3: Sues Bridge over Blackwood River. Built 1966. Tallest timber road bridge in WA.

4. Bridges on sites that are of historical importance, particularly those sites using early pre-convict or convict labour.

5. Bridges that are of significant local interest, particularly in urban areas.

A ranking system is used for most road bridges to help give each a heritage significance where:

1. There is limited individual significance,

2. The feature(s) are of some significance,
3. The timber bridge history is important at the site,

4. The current bridge, which is in use and is being maintained, has significant features,

5. The current bridge has significant features but work needed for public access to be maintained.

Fifty bridges have been given Rankings 4 or 5 and were considered to be of major heritage importance and data sheets and photographs for these bridges are contained in Volume 1 of the report as well as in Volume 2. In addition 47 bridges are on sites that are historically important as timber bridge sites (Ranking 3) and a further 45 have features of significance (Ranking 2).

10 RAILWAY BRIDGES

With the advent of railway construction in Western Australia for timber exploitation and agricultural development in the last quarter of the nineteenth century, there was no local iron production or fabrication industry. All railway construction iron work had to be imported fully fabricated. With the resulting high cost and time delays, engineers quickly turned to exploiting the abundance of hardwood for their bridge construction. At first, they used carpentry technology developed for European softwoods but very quickly developed a technology with designs suitable for Western Australian hardwoods.

In the 1950s, with the increasing availability of good quality steel and cement after the Second World War, Westrail embarked, upon a bridge replacement programme using steel and concrete. This replacement programme was necessary because many bridges were around fifty years of age and larger postwar rolling stock had begun to stress bridges above their earlier design loads.

One of the consequences of this was that bridge maintenance, together with the bridge gang workforce, was allowed to run down. By the early 1970s, when a steel and concrete bridge at Tenindewa washed away in a cyclone and had to be replaced urgently in timber, Westrail could only just muster sufficient skills to undertake the work. In recent times, Westrail has only undertaken minimal maintenance and has usually contracted Main Roads Western Australia to undertake any significant bridge work.

These circumstances have resulted in a steady decline in the number of timber bridges. This has been exacerbated by a reduction in open railways from 7,000 kilometres in 1938 to 5,800 kilometres today of which 900 kilometres is relatively new railway built without timber bridges. Of the open railways, approximately 600 kilometres is non-operating, leaving 5,200 kilometres of working railway. The result is that Westrail has roughly only 80 timber bridges on their working railway with approximately 90 on the non-operating railways. The number still existing on abandoned railways is not known but the study has identified about 130 that may still exist.

Over this period of decline, all the large timber Howe 'through trusses' that were once the hallmark of timber bridge building in Westrail, have gone. Only two bridges that have trusses still exist, these are at York and Capel. Gone also are examples of the earlier bridge building technology using crown stayed stringers with straining beams and thrust abutments; the last being the Midland Railway Company's bridge at Mogumber. Luckily, an originally crown stayed, but now altered, bridge over Ringa-Ringa Brook at Toodyay still stands. Some small examples and ruins exist on the Geraldton-Northampton Railway.

It is ironical but fortuitous that some large bridges remain on Westrail's lightly trafficked railways because the high replacement capital cost of steel and concrete cannot be financially justified without corresponding requirements for axle load increases. Smaller bridges have been replaced long ago using lower capital cost solutions, such as culvert pipes. In these circumstances, it could well be in Westrail's interest to apply the latest technology in preservatives and preservation techniques together with advances in construction techniques. In this way, it should be possible to achieve low cost piecemeal replacements as and when required, so keeping bridges operational without large capital injection.

However, not only operating bridges are at risk. Out of service and redundant bridges face natural risks such as fire and floods, development pressures and ignorance of industrial and engineering heritage values. In respect to their circumstances, one inexpensive outcome of this review should be to ensure that these bridges appear in the Municipal Inventories that the Shires are required by the Heritage Council of Western Australia to be prepared and kept up to date. This would be a logical step towards planning priorities to place bridges on the Heritage Council of Western Australia's Register of Listed Places.

Timber bridges and other large timber structures on the Trans-Australian Railway within Western Australia have not been included on the survey.

10.1 Classification of Railways

In the report, Government Railways were classified Open, Non Operational or Closed.

Open Railways

These are railways currently being operated by Westrail. Each section of Railway has a section number which is shown on the Data Sheets. These section numbers appear on publicly available Railway System Maps for the location and identification of individual railways.

Non Operating Railways

These were railways for which Westrail management suspended operating services for an indefinite period. Legally, they remain open railways and the fixed assets remain in place unless the Government Minister responsible for Railways has given permission for their removal.

Closed Railways

These were railways that have been closed by Parliament through a Discontinuance Act. This was usually combined with, or followed by, a Revestment Act vesting the land in the Crown for other specific uses. In a number of cases, no revestment has taken place leaving the legal ownership of redundant assets unclear.

10.2 Distances on Bridge Data Sheets

For open and non operating railways, kilometrage cited for a bridge is the distance of that bridge from the start of the relevant Westrail Section. For closed railways, mileage cited for a bridge is the shortest distance of that bridge from Perth or Geraldton along existing or former Westrail lines.

10.3 Railway Bridges not defined as Large Timber Structures

All railway timber bridges meeting the definition of the large timber structure and for which data was available, were expanded into data sheets. A large number of smaller bridges not meeting the criteria were also expanded into data sheets. The heritage status ranking system identifies these.

To complete a record of government railway timber bridges currently existing, both in service or unused, a list was appended at the end of the section identifying other timber bridges that were not expanded into data sheets. These bridges did not meet the defined criteria for a large timber structure and were, therefore, considered not to have industrial heritage value.

10.4 Railway Bridges not Researched

There were a number of closed sections of Government railway for which data was not readily available. These were not researched for the report. These bridges were also listed to provide a complete record.

Figure 4: Capel Railway Bridge over Capel River at Capel. Originally built in 1894. 21 x 4.6 m spans.

10.5 Railway Bridge Plans

Plans of 112 of the bridges in this section have been included in the Report as Volume 5 - Appendix. Where a bridge had plans included in Volume 5, this was indicated on its data sheet under "Notes and references".

11 FOOTBRIDGES

Prior to the Second World War, nearly all suburban railway stations had a pedestrian footbridge, generally constructed of timber. The dramatic decline in passenger traffic after the war, coupled with the ageing of these structures, resulted in them being replaced with level crossings for pedestrians.

Today, only five bridges remain and most of these have either been partially replaced in steel or have been strengthened in steel. In 1988, the timber truss at Meltham was removed for electrification works and, with the exception of Claremont, the others are under threat. In particular, the East Perth timber truss, built in the late 1940s, will be removed for the City Northern Bypass works.

Non-railway footbridges were also listed in this section, including the Munday Brook Bridge, formerly a Mason and Bird Timber Tramway Bridge, and believed to be the longest surviving all-timber bridge in Australia.

Both the Collie Footbridge and the Poole Footbridge are of considerable heritage significance and have been placed on the Register of listed Places by the Heritage Council of Western Australia. The shortest of footbridges considered to have high heritage value have been limited to the two most important ones, being the West Leederville Footbridge which is on the Register of the State Heritage Council, and the Munday Brook Bridge.

12 TIMBER COMPANY TRAMWAY BRIDGES

In the hundred years from 1870 over 6,600 kilometres of steam powered tramways plus scores of kilometres of horse-drawn tramways were built by timber companies into the forests of the south west. Called 'tramways' to distinguish them from the government railway system, the steam tramways differed very little from some sections of the government system, using similar locomotives, wagons and loadings and an identical rail gauge. In some instances, tramway locomotives even hauled their own wagons on the government system.

Although the main arteries of the tramway system remained in place for a number of decades, and some were taken over and incorporated into the government system, most of the tramway lines existed for only limited periods. They were built into areas of virgin forest and were removed after logging had been completed, and were then re-laid into new areas. Many were remarkable feats of construction, especially as they were built largely by pick and shovel. They ran through heavily timbered forest, often on steeply sloping ground, or alongside, and repeatedly crossing, rivers and creeks. A number of the main arteries of the tramway systems have been made into roads and many others can still be found

Figure 5: Hardinge Road Footbridge over Munday Brook, Kalamunda. Formerly a timber company tramway bridge, built in 1872. Believed to be the oldest surviving all-timber bridge in Australia.

in the forests with some mapping guidance. The most dramatic reminders of the tramway systems are, however, the remains of the bridges. Some, such as the magnificent Long Gully Bridge in the Boddington Shire, are now road bridges, whilst others, such as the Mason and Bird Bridge over Munday Brook, which may be the oldest surviving all-timber bridge in Australia, are now used as footbridges.

The majority of those remaining are now disused and the more important of them now require urgent stabilization if their deterioration is to be controlled. Some of these, such as the bridge over the Gardner River at Northcliffe, are amongst the most impressive railway bridges in the State, while the remains of other impressive ones, such as those in the St John Brook Conservation Park and in the Lane Poole Reserve, occur in areas of high conservation importance.

It was not possible to inspect any of the tramway bridges as part of this study. However, in 1993-94, Mr Jeff Austin prepared a report for the National Trust of Australia (Western Australia), entitled "Sawmilling, Firewood and Other Tramway" (February 1994)[5] in which he gives details of the history and location of Western Australian sawmills and their tramways and remaining rolling stock, and also of the evidence still visible of the tramway formation and associated bridgeworks.

Mr Austin had also prepared supplementary notes[6] for this study (dated January 1995) giving further details of these bridges. Extensive use of these two documents was made in preparing this section of the report. Most of the known tramway bridges or their remains have been listed, including those of quite small spans, where they were considered to be of historic or interpretative value. There are probably other less well known tramway bridges which should be listed, particularly in the Die-back quarantine areas of the forest, but their identification was beyond the scope of this report.

Former tramway bridges which are now used as road bridges or foot bridges were listed under their current use. Trestles of the colony's first railway bridge to be used by a steam locomotive, which was at Wonnerup Inlet, have been incorporated into the Vasse River Flood Gates.
In the report, it was only possible to make a preliminary review of timber company tramway bridges. It was considered that enough evidence had been provided to indicate clearly that these bridges were an important part of the State's industrial and social heritage, which deserves greater attention than hitherto given to it. It was recommended that a more comprehensive technical study should be made of these bridges to determine how they can be economically managed in such a way as to ensure that their heritage values are retained or enhanced.

13 FORESTRY BRIDGES, DEPARTMENT OF LAND MANAGEMENT (CALM)

A survey of large timber structures in Western Australia would not be fully comprehensive without the inclusion of timber bridges used for forestry operations in the State Forests of the south west, which were built for, and maintained by the Department of Conservation and Land Management (CALM). The Department's bridge inspection report,[7] dated 20 October 1994, covers 112 bridges located in eight CALM districts of Busselton, Collie, Harvey, Jarrahdale, Manjimup, Nannup, Pemberton and Walpole. No bridge inspections are listed in the Dwellingup district. Only three are trestle bridges, the remainder are low level bridges with abutments and intermediates supports of bed logs, and with logs as stringer superstructure. Forty-nine of the bridges are decked.

The 17 bridges listed in the report have been included because they were considered significant as large timber structures. This assessment was based on the somewhat arbitrary criteria of bridges with single spans of 10 metres or over, and for multiple span bridges of 20 metres or more in length. The 17 bridges noted are by no means a comprehensive list. For 39 of the 112 CALM bridges, there was insufficient data in the inspection reports to determine whether or not the bridges satisfied these length criteria.

All 17 of the bridges listed are in the Manjimup and Nannup Shires. Two significant groups of bridges consist of five along the Donnelly River and seven along Pine Creek Road in State Forest No. 35.

It was not possible to determine within the scope of the study whether any of the 112 CALM bridges might have potential heritage significance. None of the bridges listed were inspected for this report.

14 JETTIES

Since 1832, when the first timber jetty was built at Fremantle, timber jetties have played a very prominent part in the development of the State from Wyndham in the north to Eucla in the south. All of these structures were of a basic design, generally using Western Australian hardwoods for the components of the jetty.

Unfortunately, the life of the timber in these jetties was limited due to marine borers, decay and termites, apart from the relentless pounding of the sea, which claimed not only many a vessel, but also many a jetty, sometimes even before it was able to berth a ship.

Of the eighty or more timber structures, built, modified, extended or replaced in the period from 1832 to 1942, only four, Esperance, Busselton, Bunbury and

Carnarvon, still remain in part or in full. None of them are being used for their original purpose as a cargo handling pier.

These four jetties represent the major type of maritime timber structure which was used for the transport of cargo between the ship and the shore during the first hundred years or more of settlement in Western Australia. They were greatly valued as an important community asset, being recognised both locally and regionally.

Generally, most of the original components of a timber jetty which continued to be used until the 1960s would no longer be present in the ruins or in the structure, having been replaced at least once since the jetty was built. However, the ruins of some jetties, which only had a limited period of use, may still contain some original components.

The nominations for registration that were made or endorsed in the 1995 report, "Port Related Structures on the Coast of Western Australia" by D A Cumming, D Garatt, M McCarthy and A Wolfe[8] were noted and have been endorsed. Of the 21 large timber structures recommended for registration in the Cumming et al report, the Albany Town Jetty, the Carnarvon Jetty and Tramway, and the Bunbury Timber Jetty have been placed on the `Interim List' of the Heritage Council of Western Australia.

No photographs were included for jetties as they had already been supplied with the report by Cumming et al.

15 INDUSTRIAL, MILITARY, AND SERVICES SUPPLY STRUCTURES

Until well into the 1960s, timber was the main construction material for most industrial and infrastructure developments in Western Australia. A considerable number of large timber structures were built for industrial, military and service supply purposes, of which many still exist. The report presents a preliminary inventory of such structures in eight categories: air transport, maritime and port-related structures (excluding jetties which had already been covered), military, mining, power supply, railway, timber milling and forestry, and water supply and control.

The three major categories of large timber structures which it has not been possible to include in this study are pastoral and agricultural sheds, timber framed warehouses and factories (except for railway goods sheds and harbour sheds) and other buildings with large span timber roofs. These are important parts of this State's heritage and studies into each of the three is strongly recommended.

With one important exception, research into structures in this section has been largely a desk exercise to coordinate and extend work already commenced by others. The items listed hopefully include most of the important examples in each category, but in many cases, they were only a small representative proportion of the total number of examples in the State. It is hoped that the review will encourage others to carry out more extensive research into areas which have only been sparsely covered.

The observation fire tower is another important type of large timber structure in this section which was surveyed in the field. During 1997-98, the most important remaining examples of timber fire towers and tree lookouts in the south-western forests were inspected by Mr Lloyd Margetts of the Heritage Panel's Working Party, and a preliminary short list of those with important heritage value made.[9]

Several important large timber structures, such as the two hangers at the former Maylands Aerodrome, and the Nungarin Army Store, have been included in the report in outline only as they have already been assessed by others. They have been included in this report because, in addition to their importance as fine examples of buildings of this type with important historical associations, they are also important as outstanding examples of the structural use of timber in very large military and aviation buildings.

Figure 4: Grevillea Fire Tower. Built 1940. Tallest timber fire tower. 42.7 m high (10 ladders and 9 landings).

16 AIR TRANSPORT

The only items included are the two hangers at the former Maylands aerodrome, both of which are of great historic and technical importance. Other timber airport buildings may exist at other aerodromes used during the 1930s or were built during the Second World War and subsequently used for civilian purposes.

17 MARITIME AND PORT RELATED STRUCTURES

These include a number of unusual structures, such as the Albany Floating dock, which came to light during Mr Denis Cumming's studies of maritime structures and light stations. Also included were large timber warehouses at ports, and bridges and other structures on various tramways that served a number of Western Australian ports.

18 MILITARY

The former No 5 Base Ordinance Depot (BOD5) building at Nungarin, which may be the largest building with a fully timber framed structure in the State, is a magnificent example of typical military timber construction. There may well be a number of other significant large timber structures built for military purposes still existing in the State, some of which may still be used for defence purposes.

19 MINING

The boom in gold mining in the 1980s and 1990s has unfortunately resulted in the loss of most of the old timber headframes and other mining structures. Two very important examples of early Golden Mile Headframes and an ore bin have been preserved and reconstructed at Hannans North Mining Historic Mining Reserve. The Sons of Gwalia Headframe has also fortunately been reconstructed at Gwalia. Other examples of timber mining structures may also exist in less well known mining centres. Several small headframes have been listed in the Northampton Mineral Field, and others may exist in other base metal mining centres. Because of the comparative rarity of timber mining structures, the term 'large' in this sub-section was applied quite liberally.

20 POWER SUPPLIES

Large quantities of timber have been used in this State for the transmission and reticulation of power supplies. The 'pi' structure, which was used for several major long distance transmission lines, was the largest of all timber structures used for transmission lines in this State and relevant examples were included in the report.

21 WATER SUPPLY TANKS

One large timber structure that figures prominently is the water supply tank which has long been the point of identification of many rural communities as well as being of major importance for supplies to steam trains. In many instances, railway tanks are now used for local water supply purposes which has assisted in their retention. A large number of timber framed goods sheds and several signal boxes were listed, and although not a particularly large structure, a timber derrick of the standard type was included, as it is probably the last example of its type left in the State.

Only large timber railway structures, which are more than 30 years old have been included in the report. In preparing this section, Ms Phillippa Uhe's report prepared for the National Trust of Australia (WA) and entitled "Survey of Railway Heritage in Western Australia" (2 parts) proved most useful.

22 RAILWAY GOODS SHEDS

Westrail have used standard forms of goods sheds. All have timber superstructures and were sheeted with either weather board, corrugated fibro-cement or galvanised iron. There were five sizes, the two largest having trussed roofs and the smaller ones with skillion roofs. Only the trussed buildings were considered to meet the criteria of 'large timber structures'.

All attended stations throughout the railway system had goods sheds, including those in the metropolitan area. All major towns and junctions used the large size. Most of the larger towns, and many of the metropolitan stations, used the second size. There were probably about 100 of the larger two sizes on the total system. These sheds remained in use until Westrail relinquished its common carrier charter and abandoned less than wagon-load traffic in the early 1970s.

The goods shed was arguably the most important building in most Western Australian railway yards. In the 1993 report 'Survey of Railway Heritage in Western Australia Vol 1 - South of the 26th parallel' prepared for the National Trust of Australia (WA)[10] by Ms P Uhe, goods sheds were dealt with in a cursory manner. The report's only recommendation specifically related to goods sheds that were considered for assessment as part of station yard complexes, notably at Narrogin, Mukinbudin, Donnybrook, Pemberton and Bridgetown, together with an example of one small country goods shed. Whilst the her-

itage registration of railway yard complexes is considered the most desirable method of recognition of the heritage of railway buildings, it should be noted that a number of goods sheds that are of value, both as railway heritage and as local community assets, occur outside potential railway heritage complexes.

The goods sheds in the report were generally those in the two largest categories, each with trussed roofs. The locations have mostly been taken from the 1993 Westrail report Asbestos / Historical Register of Westrail Properties.[11] This list does not include goods sheds on closed railway lines. Of the 42 listed, 17 were not included in the 1994 National Trust Report. It was recommended that a further examination of the heritage value and existing status of these buildings be made, particularly those that do not exist within the recognised railway heritage complexes.

23 RAILWAY TANK STANDS

In 1938, when the railway network had expanded to a maximum, there were approximately 250 water supply installations. These installations were normally self contained with catchment and storage dams, pumping equipment, holding tanks with stands and delivery systems to locomotive water columns. Even the external sources of water were available, such as in the city. The requirement of quick filling of locomotives from a 150 millimetre diameter supply water column required the use of high stands to provide the necessary pressure and volume. Most early tank stands were constructed of timber.

The introduction of diesel locomotives in 1953 heralded the staged abandonment of railway water supplies, initially in the dry Northern and Eastern Districts, and finally in the South Western District in the early 1970s. The water supplies were then gradually handed over either to the Country Water Supply Department for regional schemes, or the Public Works Department or Lands Department. Some of these are now in Shire ownership for landscape reticulation.

Although this inventory was not complete, it included a number of examples of large timber tank stands which remain in various states of repair.

24 FORESTRY AND TIMBER MILLING

Over fifty-five observation posts have been built in the forests of the South-West of Western Australia in the last 60 years in the form of timber towers, lookouts on tall trees, and steel towers or huts on elevated ground.

There are nineteen significant timber towers or lookouts. The towers are large timber structures by any standards and tree lookouts have been included because the construction of lookouts on trees of over 20 metres in height were in themselves not inconsiderate feats of timber construction.

Factors considered in the short listing of these structures for heritage assessment were:

1. Technical interest
   - Height
   - Innovation (including timber splicing)
   - Construction techniques (including hand axe-work)
2. Age
3. Maintenance features
   - Whether still used
   - Public accessibility (if easily accessed and quite "public", vandalism would probably become a less serious problem).
4. Dieback Restriction
   - It would be hard to justify heritage / Area Status "tourism" funding for a structure to which general access is prohibited.
5. Originality.

Over sixty saw mills operated in the south west in the hundred years from 1870, most of which were housed in large timber buildings. Few of these remain. Many were burnt down and others were moved to new sites. The few important examples remaining were listed but a fuller inventory of all aspects of timber industry heritage is badly needed.

The fire tower was another important type of structure included in this category.

25 WATER SUPPLY AND CONTROL

One type of large timber structure in this class which was omitted because of time limitations was the timber support structure for roofs to service reservoirs and rock catchment collection tanks, of which there are a considerable number in the State. A further study of these was recommended.

Two large timber flood control structures are included but irrigation control structures have not been researched.

26 CONCLUSION

In total, some 850 structures were listed of which 139 have been selected as having a high degree of engineering heritage which should be considered for one or more official 'Listing'.

The report covers a very broad spectrum of 'large timber structures' in Western Australia. The main focus was to initially identify those structures that met the criteria of a 'large timber structure' and then to document them before they became either redundant and were replaced or deteriorated to the stage of becoming ruins.

Structures that were deemed to have a high degree of heritage significance were singled out for recognition either on the National Estate, listing by the Heritage Council of Western Australia, or by entry on the Municipal Inventory of all Local Government Authorities.

'Time' was an essential element in the preparation of the report as it was felt important to have it completed before too many of the structures 'disappeared'.

In total, some 850 structures were listed of which 139 have been selected as having a high degree of engineering heritage which should be considered for various degrees of 'Listing'.

The completed report covers five volumes. Volume 1 lists the procedure adopted together with the details of the 139 structures recommended for listing. Volume 2 covers the Road bridges with Volume 3 covering the Railway bridges. Volume 4 covered all the other types of structures with Volume 5 supplying detailed drawings of many of the Railway Bridges.

In presenting this paper, I cannot stress too strongly the necessity for all areas of both Australia and New Zealand to make an immediate effort to identify and document their 'large timber structures' before it is too late.

Finally, I would like to acknowledge the great effort put in by the late Denis Cumming in starting the project in the first place, and, following his untimely sudden death in January 1995, to the members of the Editorial Committee of the Western Australia Division of the Institution of Engineers, Australia, Heritage Working Party and the many other helpers who collected and collated the data into the final report, which I have used extensively to supply most of the contents of this paper.

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